B

USINESS

UDGETING

IN THIS ISSUE

NSBB

NATIONAL SOCIETY FOR BUSINESS BUDGETING

NATIONAL OFFICERS AND DIRECTORS 1960-61

President	Arthur D. Moor, United Air Lines, Inc.
Vice President	Donald C. Bacon, R. R. Donnelley & Sons, Co.
Secretary-Treasurer	Bernard W. Schaller, Theo. Hamm Brewing Company
Administrative Secretary	Melvin C. Aichholz, P.O. Box 448, Cincinnati 44, Ohio
Past President	R. Visscher Millar, Pennsalt Chemicals Corp.

REGIONAL DIRECTORS

Region I	George W. Jackson, Electric Storage Battery Co.
	Jack L. Selke, Central Industrial Bank
Region II	Henry K. Wallstrom, The J. L. Hudson Co.
	Henry M. Leigh, Diamond Alkali
Region III	Neil F. Denen, Iowa-Illinois Gas & Electric Co.
	V. K. Kowalsky, Ernst & Ernst
Region IV	Walter A. Verbeck, International Harvester Co.
	C. S. Holsteen, United Air Lines, Inc.
Region V	Frank Judd, Brown & Williamson Tobacco
	Charles W. Kessler, Price Waterhouse & Co.
Region VI	H. Richard Hawley, Cutter Laboratories
	John B. Morgan, Convair-Astronautics

CHAPTER PRESIDENTS 1960-61

Atlanta	Larry B. Barnes	Nashville	William K. Clay
Baltimore	Robert E. Thomas		Tenn. Products & Chem. Corp.
	Arcrods Company	New Mexico	Richard F. Eagle
Boston	Albert A. Schaake		U.S. Atomic Energy Commission
	Bolta Products Div.	New Orleans	Elvin S. Cobb
Bridgeport	C. M. Gionta		Bd. of Port Commissioners
	H. O. Canfield Co.	New York City	Bertram Broder
Calumet Region	Herbert B. Conrad		I.B.M.
	Ingersoll Products Div.	Niagara Frontier	John P. Mallick
Canton	G. B. Raisner	Northern New Jersey	Clement A. Agresta
	Tyson Bearing Co. Div.		Whellock Signals, Inc.
Chattanooga	Paul M. Eldering	Peoria	John W. Galvin
	Bowaters Southern Paper Corp.		State Farm Life Insurance Co.
Chicago	Vernon Rutter	Philadelphia	Charles A. Pfahler
	Intl. Min. & Chemical Corp.		Sun Oil Co.
Cincinnati	Martin B. Perkins	Pittsburgh	Irvin E. Zacher
	Williamson Co.		H. J. Heinz Co.
Cleveland	Lawrence F. Williams	Rhode Island	Porter S. Wood
	Jones & Laughlin Steel Corp.		University of Rhode Island
Dallas	Kenneth R. DeCelles	Rocky Mountain	Charles H. Newton, Jr.
	Texas Instruments, Inc.		Public Service Co. of Colo.
Dayton	Charles L. Ross	Shreveport	Warren H. Carr
	Price Brothers Co.		Texas Eastern Transmission Corp.
Decatur	Howard D. Rice	St. Louis	Robert E. Hellmann
	Lehn & Fink Products Corp.		White-Rodgers Co.
Detroit	John A. Jansma	San Diego	Robert John Schier
	Ford Motor Co.	San Francisco	Gerald Wentworth
Fox River Valley	A. Gerald Avant	Skokie	Walter P. Weber
	Elgin National Watch Co.		Bell & Howard Co.
Hartford	Salvador P. Mute	Tri-Cities	Henry C. Doofe
Houston	Raymond E. Emery		American Machine & Metals, Inc.
	Texas Eastern Transmission Corp.	Twin Cities	David E. Henderson
Indianapolis	Robert E. Sexton		Minneapolis-Honeywell Regulator
	Cummins Engine Co., Inc.	Toledo	Richard W. Nopper
Joliet-Kankakee	Richard C. Kocher		Johns-Manville Fiber Glass, Inc.
	Caterpillar Tractor Co.	Utah	William G. Nevers
Kalamazoo	Joseph G. McCarthy		Thiokol Chemical Corp., Utah Div.
	Michigan Carton Co.	Western Florida	Don Kuchenbuch
Kansas City	Wesley M. Smith		Anheuser-Busch, Inc.
	Real Kill Co. Div.		
Los Angeles	John Proeschel, Jr.		
	Hunts Food		
Louisville	Paul R. Jacoby		
	P. Lorillard Co.		
Milwaukee	Kenneth H. Bennett		
	Cutler-Hammer, Inc.		

In Memoriam . . .

Tragedy struck suddenly as an aftermath of the Dallas conference. Neil Denen, the Editor of Business Budgeting, died on May 29, following an auto accident on his way home from Texas. Neil hadn't felt well at the conference. He considered selling his Volkswagon in Texas so that he could return by plane.

Since his wife, Evelyn, had accompanied him, he decided to drive back Saturday morning. When they neared the town of Monett in southwestern Missouri, the car's wheels caught in the shoulder of the road causing it to overturn. Neil riding as a passenger was thrown from the car which landed on him causing critical head injuries. He was transferred to a Springfield, Mo. hospital where he succumbed two days later without regaining consciousness. Evelyn remained in the hospital with multiple injuries, but is now recovering rapidly at the home of her sister in East Moline, Illinois.

Neil was an ardent follower of automobile racing. He thought nothing of taking off for Florida in his Volkswagon to attend the over-the-road races at Sebring. He brought the same enthusiasm to his work in NSBB. Neil was a charter member and past president of the Tri-Cities Chapter. Last year he served as National Director representing Region III.

When Neil became Editor of Business Budgeting on July 1, 1960, the Annual Report stated, "Mr. Denen is not only a skilled Budgeteer, he also is experienced in editing and producing technical material. The Society and its magazine are fortunate to have his services." Now we are sad to report that this is Neil's last issue almost ready to go to press when he was called away. ▒

LONG RANGE PLANNING

Business planning may be compared to the design of a new product. First the general idea is conceived. Then it is drawn up in a master plan, properly supported by detailed blueprints of the various components. By increasing numbers, American business is finding that its operations can be more efficiently conducted and profits greater where management has given careful study and attention to long range planning. This topic was the subject of a panel discussion at a recent Detroit Chapter meeting. Appearing on the panel were Robert K. Schaffer, Budget Supervisor, Vickers Division of Vickers, Inc., Detroit, who authored Part I, "Setting The Goals"; Robert L. Eady, Budget Analyst, American-Standard Co., Industrial Division, Detroit, author of Part II, "Basic Considerations"; and Harry Cagle, Accounting Supervisor, Budgets, Wyandotte Chemical Co., Trenton, Michigan, author of Part III, "Development Of The Plan".

Part I

SETTING THE GOALS

Setting the Goals is the first phase of long range planning. This is the first phase of consideration for any planning. In setting these goals a company or concern must first consider what they want to be and what they should be in the next 10, 20, or 30 years. Secondly, as it pertains to long range planning, a company must give consideration to 'expected-return' on investments for the future. And finally, a company should decide on their future rate or growth.

What Do We Want To Be and What Should We Be In The Next 10, 20 or 30 Years

In deciding the company's position for the future in the years to come, consideration should be given to three points: ownership characteristics such as its influence on community position, prestige, bigness, etc.; the number of product lines or lines of service; and the type of growth such as local, regional, national, or international.

Ownership Characteristics

Ownership characteristics may have influence on future planning. In this connection, community position may require some consideration. If it is not the policy (or need for a policy) to put the company's name before the general public, such as goodwill type of programs, then it may be wise to avoid moving into a community where this sort of thing may become a requisite. For example, a company may move into a community where, because of the magnitude of its economic influence, it becomes necessary for the firm to contribute considerably more time and money than the company policy normally dictates for community projects such as United Fund Drives, YMCA campaigns, etc.

Size of physical assets may also be an ownership characteristic consideration. Along this line of growth, particularly if moving into new manufacturing ventures in the area of government work or perhaps even subcontracting business, physical assets may be owned completely by or jointly with the customer. For reasons of business flexibility, the policy of the concern may want to avoid this sort of tie-up. In addition, the ownership may be influenced by growth within limits of its present assets, consequently making its progress through the introduction of new products rather than through expanding and pushing present lines against competition. And, of course, management may be tempered in its expansion of assets for future growth by its ability to acquire additional facilities. These considerations do point out a need for serious thought about physical assets. The paramount question is: Will an adequate return be realized if facilities are greatly increased or overhauled?

The character of management may be such that personal prestige associated with large growth and bigness may be an influence on future planning.

Independence of operation may well be another management characteristic influencing long range plans. Management may prefer to grow on its own without the use of proprietary rights: that is, management may prefer to make their own engineered or designed products rather than make a product of someone else's design for sale to a customer. This may cause growth to be slower, but perhaps steadier and surer. In maintaining this type of independence, management may sacrifice growth in bigness, but this will probably insure a better control of economic stability in its business; it may also require considerably more effort by management for growth in their long range program. Another aspect of independence of operation centers on management maintaining financial independence from outside dilution of control through extensive financing for a future expansion program. Therefore, it may be desirable to maintain independence from outside financing as a consideration for future planning, and this may well have an effect on the extensiveness of future planning programs.

How Many Product Lines

The second consideration as to what a company wants to be and what they should be in the future concerns the number of product lines or lines of service. The product consideration is certainly a very important part of future plan-

ning. New product lines may be developed and added in a gradual process of extended development of the company's basic product line, or there may be a definite break from the old line to a new type of product. At any rate, management must make decisions concerning new product developments. However, in regard to how many product lines or lines of service, it seems that the number of product lines or lines of service would be influenced by the desire to serve the customer and at the same time make certain that the company's future will not be endangered by failing to recognize the true purpose of the business. It must be noted that customers are not really purchasing a product as such, rather the customer is buying a service or a need to suit his own purposes and necessities and he will purchase that product which best performs to his requirements at the lowest over-all cost. With reference to Mr. Theodore Levitt's article in the July-August 1960 Harvard Business Review, "Marketing Myopia," we can say that being customer-oriented rather than product-oriented is a must for any type of a planning program. Mr. Levitt sights a number of examples where short-sighted management endangered their company's future by improperly defining their business purpose. As an example, he describes how the railroads did not stop growing because the need for freight and passenger transportation decreased, because it grew. The increased need was simply filled by other forms of transportation: such as, cars, trucks, airplaines and even telephones, because it was not filled by the railroads themselves. Customers were taken away from them because the railroads were railroad-oriented *not* transportation-oriented. Therefore, it may be necessary to consider additional product lines or lines of service that fit within the whole scope of the purpose of the business and, to the extent that failure to satisfy customers, may have a depressing effect on the old line bread-and-butter business.

Another point should also be considered in adding new lines or redesigning or redeveloping established lines. A watchful eye must be kept on the development program for products to keep it in balance with your own company's or another company's progress toward a superior substitute that will cause product obsolescence. It may be necessary in some types of businesses to maintain sufficient product lines to avoid the possibility of being endangered by product obsolescence.

What Type of Growth

Under the consideration 'what a company wants to be and what they should be in the future,' we should consider the type of growth. Will it be confined to local, or regional, or national or even international? The nature of the business may determine the answer. Possibly because of doing business with a company of national or even international scope, through the interlocking of your product with your customer's product your firm may find itself in a national or international type of growth. As an example, the mere fact that your firm as a vendor may supply an important part that is part of the product that your customer sells nationally or internationally may compel your firm to expand the operations to national or international scope. Therefore, management must give definite consideration to the extension of its area of operations for future planning and give consideration of its ability to extend itself.

At this point, it should be noted that there may be many more facets of discussion as to what may be a firm's future aspirations. The purpose here has been to stimulate ideas for discussion.

Return on Investment Considerations

The second point of consideration in setting the goals for future planning is the return on investment.

The basic objective of a business firm in the United States is to earn a fair or competitive rate of return on its investment. Although a business firm may have many worthy objectives, the ability to meet these objectives depends on its ability to earn a fair rate of return on its investment. All other objectives merely complement it. Thus, the basic objective of investment expenditures is to make a profit; additional investment should be dictated by profit profitability consistent with the long range master plan.

What Rate of Return

Of what rate of return should a business firm expect on the investment of long range planning? Obviously, a business must strive to provide a rate of return that will cover the costs of not just being in business, but staying in business. This means that a return must cover such costs as replacement, obsolescence, market risk and so forth. In addition, an adequate rate of return is good insurance for a supply of capital for future programs.

Insofar as long range planning is concerned, there is no way to assure an adequate rate of return, and this places a greater stress on the need for good sound planning. Setting an exact rate of return (of say 20% before income tax) may or may not be justified, depending on the business risk involved. A 10% lower rate may be quite adequate if the business risk of failure is practically nil. A 10% higher rate may prove inadequate if the business risk of failure is particularly high. Therefore, an exact measurement of a return must really rest with the judgment of management in their appraisal of what is required as an adequate return as applied to their business.

Source of Investment

Another point of investment consideration is the source of capital for investment. As stated, a profitable rate of return is good insurance for a supply of future capital — if not directly from the undivided profits, then indirectly through providing sufficient inducement for new outside investments. Therefore, any capital requirements for future planning should consider the method and the firm's ability to acquire capital. Concerning the independence of operation, outside financing for future planning must be weighed against the possibility of losing some independence of operation.

What Rate of Growth

The final consideration for setting goals for long range planning rests with the decision as to the rate of growth. True business growth is the result of success, and it is normally because of able and competent management. But setting a rate of growth is for the most part a matter of management attitude. Certainly a firm should establish a growth goal as part of its long range planning. Business growth could probably be defined as a definite increase in one or more of such factors as sales, physical assets, or employee organization provided, of course, that the latter two factors are not the mere 'addition of fat.' The goal for the rate of growth will vary according to the type of business or industry. There are, of course, various factors to take into consideration. Certainly, a business would normally expect their growth to at least equal, if not exceed, the estimate of the industry growth. It seems justified that some increase in industry's market penetration for future planning would be a desirable objective. Since a company grows because it is doing a good job, management must

make an appraisal of its ability to perform with increased efficiency and proficiency. In addition, management may appraise its growth on its ability to master a particular technology which will result in the opening of new markets because of research producing new products. Then, there would be defense spending considerations for those firms engaged in defense work, and this would be influenced not only by the amount of spending but by the type of defense products.

As mentioned before, the rate of growth is largely a decision based on the management's attitude. Certainly, however, no alert management would be content to just remain static, since this is a process of falling behind toward business failure.

In summary the intent of this discussion has been to touch on some of the factors involved in setting the goals for long range planning.

Part II

BASIC CONSIDERATIONS

Key Influences To Industry Growth

1. One of the keys to industry growth is our steady increase in population (statistics show this to be at the rate of 20% over the next 10 years.) Another key influence and probably the most influential at this time is the 12-½ billions of dollars American Industry is pouring into the research and development of new products.

2. Tied into these aspects is what the per capita consumption of our own products will be. For example, in the automobile industry, it would be necessary to forecast how many families will go to two cars, and further, whether this group will desire two regular size cars or one compact and one regular size car. Certainly another factor here is what the economic climate of the nation will be and what rate of growth we may expect. In the recent national election campaign the then Senator Kennedy said our economic growth should be 5%, and Vice President Nixon said it should be 3%. The distinction between the party platforms on the growth rate necessary for America is one of philosophy. Basically, Republicans believe that industry should grow without manipulation from outside sources, in this case, the government. Democrats adhere to government stimulation, when necessary, to induce growth. This belief stems from the philosophy that the consumer and his ability to spend is the crux in our economy. Lord Keynes was the major proponent of this philosophy and it is a keystone in Democratic thinking. Depending on what you think is the best way for us to grow

puts you in one camp or another. Both approaches have merit but one says the government has an obligation to help the process along more strongly than the other. Thus, the philosophy of the party in office has to be considered in our business thinking.

3. With an "insight into" and "forecast of" just what new products we expect to market and what improvements are necessary for already established products, we can begin to make specific plans for research and delevopment. As you can well appreciate there is a lapse of time, from the moment a product goes to the drawing board, is tested and tooled for manufacturing, and lines of distribution are established for the ultimate sales to the consumer.

Evaluate Company's Ability To Carry Out Long Range Program

1. Here we must consider the competence, maturity, know-how, desire and ability to lead, of our Management Team. It is my opinion that for a large company to be successful there should be a blend of age and youth in this Management Team. Neither too much age nor too much youth will produce the wisdom and physical effort necessary to make a large corporation function. In brief, too much age leaves a large vacuum upon death, termination, or retirement, and a disproportion of youth leaves a vacuum in patience, understanding, and overall know-how; therefore, we should have a proper blend of age and youth, or in

other terms "proper and good bench strength."

2. We must also consider whether we have proper and adequate means of distribution. For example, do we have a branch sales office in a particular city where there is sales potential and where possibly our competition is already located. In this consideration of distribution, think for a moment of all of the different items that you are accustomed to purchase in one type of specialty store that you can now purchase in a hardware store, or a food market, or the 5 & 10, or the corner drug store.

3. If we are going to prepare in our Long Range Plan for the extension of a product line into additional sizes, or add new products, or just produce more of what we are already producing, we must consider whether we have the necessary facilities to produce, and, if not, how soon will we have to start building additional factories. Where will the most advantageous location be from the standpoint of favorable labor conditions, favorable distribution to our markets, ready sources of necessary materials, favorable business tax structures, etc. Last but not least, what will our financial picture be at the specific time we start to build, or for that matter make any capital expenditures.

Product Life Cycles

1. Here we must consider the life expectancy of not only our present products, but those we intend to introduce in future years. For example, the manufacturer of toys is continually faced with the problem of coming up with new toys, because we grown-ups just get tired of playing with Hula-Hoops. Another example of change in a present product would be the shift in the types of airplanes used in air travel. With the necessity of more speed and comfort, we are now changing from the gasoline powered propeller type of airplane to the swift and silent Jets. It probably won't be too long before the gasoline type of airplane will be as out-dated as last year's calendar.

With continuing changes in products, we have to consider also how changes in competitive products will force us to modify our products or services. Take the new high speed Jets mentioned above; what do you think the catering companies are doing to

offset the discontinuing of serving food enroute on some of the trips that now serve food?

The last consideration here is, do we have new saleable products coming out of our Research and Development Area at the right intervals, and are we improving our present products in order that they might be ahead of products manufactured by our competitors. In other words, are we researching "Costs Out" while maintaining product performance and the desired profit relationship.

Cost Trends

1. With the present trend of wages and materials upward, we must work with our vendors to see what improvements they are making in materials we purchase from them for use in the manufacture of our products. For example, the other day I was talking to one of our buyers of bearings and he was pointing out that one of our suppliers had come up with a new type of bearing that would adequately replace our present bearings and be cheaper, since we were their only buyer of the older type of bearing.

2. We must keep our Pay Scales in line with those paid in our area for similar work, in order to keep the employees happy and producing effectively, and ultimately, producing a fair return for the owners of the business.

3. We also have to consider that we have "tooled" the product properly and that we are producing it in the most efficient manner, and in general, that we have the right equipment to do the job.

Organization Structure and Timing

1. Here one of the questions for consideration, where we operate several plants, is whether we Centralize, Decentralize, or Recentralize. There is no set rule. Many companies are trying Decentralization. All I can say is that it takes time and effort to determine if it pays off for your particular company.

2. By timing, I would think we should consider "Is our House in Order" and "Are we prepared and able to carry out the Action necessary to make our Long Range Plan Succeed."

Alternatives

1. I feel there is no doubt that we need Long Range Planning, but sometimes unforseen

things crop up and to quote an often used phrase "The Best Plans of Mice and Men Often go Astray." We should always be prepared for a change in plans. Recently Manpower, Money and Materials went into the Edsel and to again quote some of our own members' remarks, "It was something less than a Howling Success," but other plans at Ford did pick up the ball, and by this I refer to the Thunderbird and Galaxie. Further, at Ford they had another project in Development, that being the Compact Falcon and they, along with General Motors and Chrysler, are quite successfully entering a new market.

I would like to sum up my part of this discussion with a quotation appearing in the book entitled "Business Budgeting" put out by the Controllership Foundation, Inc.

"It is essential to the successful operation of a dynamic, growing business concern that the magnitude and speed of its growth be given careful consideration, and preparation be made to develop its resources in an orderly manner."

This we do with Long Range Planning.

Make no mistake about GROWTH; in today's business world no one guarantees you a certain percentage of the market at a fixed profit rate, and either you grow by using your resources wisely, or else you shrivel up and become Alumni in the National Corporate Listings. Long Range Planning is a tool that can make your company's future a success.

Part III

DEVELOPMENT OF THE PLAN

Before starting to develop the Long Range Plan we must do three things. First, we will need a statement of our goals or objectives from the Chief Executive Officer of the Company. Second, we will most certainly need Estimates of the Situation, from executives responsible for individual functional areas.

Third, prepare the Consolidated Estimate of the Situation, keeping always in mind the goals and their frame of reference. We should stress that any Estimate of the Situation and any Long Range Plan must be custom-made for our individual company.

What is an Estimate of the Situation? In it we recognize the objectives. We systematically and thoroughly examine the alternative actions and methods which may lead to fulfilling the objectives. We consider the influence of external and internal factors upon carrying out the possible courses of action. We select the best course of action after thoroughly examining all alternatives. The selection of the best course of action for our company is the decision of the Chief Executive Officer, and it may be approved by the Board of Directors.

Planning Program

A Long Range Planning Coordinator is formally appointed. He may be the Controller, the V-P for Planning or another qualified executive. The Coordinator develops a formal program for completing the Estimate of the Situation. The decision as to the length of the planning period and of its parts are indicated in the program. Tasks are assigned to the specific executives responsible for individual functions, such as sales, production, and research. All functions, and I stress the word ALL, are affected by factors which influence long range planning. Specific target dates are set.

The planning program is developed and published with the help and approval of the executives who will participate in developing the plan By having a program we avoid duplication. We increase efficiency by listing assignments to cause natural coordination and liasion. We encourage spontaneous, freer exchanges of ideas, get better understanding of other's problems, and, most importantly, keep the Estimate of the Situation aimed directly at the stated goals. Lastly, but quite important, it is easier to obtain concurrent planning of parts of the Estimate of the Situation before any parts are actually completed. Concurrent planning is absolutely necessary, if each executive is to have enough time to evaluate thoroughly the factors influencing possible courses of action in his area.

Economic Conditions, Business Environment, and Goals

We evaluate the general economic conditions nationally and internationally as the first step in developing the Estimate of the Situation. We use information about the security of foreign invest-

9

ments and the degree of freedom in using funds generated in foreign investments. The capabilities of national and international competitors are evaluated. Estimates of the Gross National Product, interest rates, effects of current and potential local, national, and foreign government regulations, and information on all other factors affecting general economic conditions are obtained. The task of completing the evaluation of general economic conditions should be assigned to the best qualified individual. A target date will be set.

Next we estimate our market and the business environment within the framework of the projected national and international economy. We draw general conclusions in these areas. We estimate family, industry, and government spending for our products. This is our market. We evaluate the prospective situation, technological changes, social changes, new methods that may affect systems and procedures, or products, and all the other aspects of the business environment that may affect our individual company. The Coordinator probably will develop the over-all evaluation of the market and the business environment through consultation with executives in functional areas and from data already available to him.

At this point, a review of the reasonableness of the objectives against the conclusions made regarding the general economic conditions, the company's market, and the business environment is necessary. The goals may be retained as originally set or they may be revised. This decision must be made by the Chief Executive Officer. Now is the time to formally publish the adopted goals as company policy.

Developing Course of Action

The executives in the individual functional areas at this point begin to concentrate upon planning courses of action to make their functions lead to fulfilling the company goals. Functional goals are established. The need for spontaneous exchange of ideas between functional executives becomes critical at this point.

Marketing. The Vice President of Marketing develops a comprehensive Marketing Estimate of the Situation. He depends upon the Vice President, Research and Development for ideas regarding the life of current products and future products. He seeks information from the Vice President, Engineering regarding current and prospective facilities, their capabilities and locations.

The Coordinator advises the Vice President, Marketing of what general contents are needed in the Marketing Plan. Historical marketing data is made available to the Vice President, Marketing by the Coordinator.

Forecasted sales of present products by product or product category are made. Forecasted sales of new products to be introduced through research or acquisition are prepared. If design is a factor, the frequency of design change necessary to reach the marketing goal is decided.

The effect of competing products or new ways of satisfying the need are explored. For example, will a monorail system of mass public transportation be installed with federal and state aid? What effect will this have upon the number of prospective one and two-car families?

What is the total national and international market for products or categories of products? What percent of the total market do we plan to obtain in each period of the plan?

A sales analysis is part of the Marketing Estimate of the Situation. What will be our sales policies and programs? What size sales force, jobber distribution system, or other type sales effort will be used for individual product lines?

How much advertising by product line? In what media? What size territories should we have for individual product lines? What territories offer the greatest potential for sales growth in product lines? What will we do about introducing and deleting brands?

If we use dealers or jobbers, how do we plan to improve their effectiveness? How will we measure their effectiveness? How can use of Electronic Data Processing Machines help us to collect, analyze, and use sales, production, and inventory data?

How much technical service will we provide for individual product lines? Will we use our own technical service organizations or purchase professional service from an outside agency? What kind of people will we need for technical service?

Production. The Marketing Estimate of the Situation helps the Vice President, Production to prepare a Production Estimate of the Situation. He will decide which plants will be used to produce current products.

Based upon exchanges of ideas with the Vice President, Research and Development and the Vice President, Engineering, the Vice President, Production develops courses of action regarding the capacity of new plants to produce new products. He explores sources of current and future raw materials with the Director of Purchasing and the Vice President, Research and Development. If one goal is to vertically integrate the company, the facilities and manpower to operate

mines, oil wells or other sources of raw material become planning factors.

Research. The planned schedule of introduction of new products is spelled out in the Estimate of the Situation developed by the Vice President, Research and Development. He indicates the degree of concentration of research on existing products, processes and manufacturing, and new products. The projected staffing and research facilities's requirements are projected.

Personnel. The Vice President, Organization and Personnel projects the availabilty of personnel to man each of the projected functional areas in his Estimate of the Situation. A shortage of people in the 25-45 age group is recognized. He recommends remedial actions to overcome any shortages of specific categories of personnel. Training programs for development of management and other personnel are projected. Wage and salary projections are estimated.

Finance. The Coordinator works with the Treasurer in expressing individual functional plans in terms of dollars in the Finance Estimate of the Situation. The projected return on investment is compared with the goal. If the projected return on investment is found to be too low, parts of the Estimate of the Situaion may be referred to the functional executives with appropriate comments and suggestions. The functional Estimates of the Situation must coincide with the frame of reference set by the goals.

The Coordinator assigns responsibility for estimating capital requirements and sources. Profits and depreciation are the major internal sources. Requirements are for new, expanded, or modernized facilities, for dividends and working capital. Sales of stocks or bonds, or long-term loans may be projected for part or all of the facilities requirement. Short-term or seasonal working capital requirements may be projected as being satisfied by short-term bank loans.

Consolidated Estimate of the Situation. The Coordinator uses the Estimates of the Situation prepared by the individual functional executives to complete the Consolidated Estimate of the Situation. The Coordinator may pretest the over-all decision by using the business game technique to evaluate alternatives. Computers are necessary for processing the mass of data to be analyzed by the business game technique, if several alternative courses of action have been studied in the Estimate of the Situation.

Each participating executive arrives at a decision, a course of action, for his functional area. These decisions are reached in collaboration with other functional executives. Their decisions are aimed directly at the company goals.

Course of Action. Now a decision on the best over-all course of action is made by the Chief Executive Officer. The success of this adopted course of action depends upon the wholehearted support and efforts of the executives who worked on the Estimate of the Siuation. Although only one course of action is adopted, other thoroughly evaluated courses of action remain in the Estimate of Situation for use in case of sufficiently important changes in elements that can be fatal to the adopted course.

Long Range Plan. The Long Range Plan is developed on the basis of the approved course of action. The attention of management is focused on the major problems foreseen in carrying out the decision, the assignment of tasks, the timetable for accomplishing tasks, and the organization to accomplish the tasks in the Long Range Plan.

The final step is the supervision of the planned course of action to assure meeting the goals despite changing and unforseen conditions. As a final alternative, if conditions change drastically enough to be fatal to vital elements of the adopted course of action, an alternate Long Range Plan may be prepared. The wisdom in thoroughly preparing an Estimate of the Situation bears fruit at this stage by providing a ready course of action for the changed conditions.

Through collecting, analyzing, and interpreting new information, the Coordinator is able to be aware of present progress and future possibilities in reaching or surpassing the goal of the Long Range Plan. Each executive leads his functional area toward the goals of the adopted course of action and measures his progress. The Coordinator keeps the Chief Executive Officer and all executives in management informed of the degree of progress attained.

In Summary

Goals or objectives are set by the Chief Executive Officer.

A Consolidated Estimate of the Situation is developed by a Coordinator of Long Range Planning from functional Estimates of the Situation prepared by the participating executives.

The Chief Executive Officer makes a decision as to the best over-all course of action after reviewing the alternatives in the Consolidated Estimate of the Situation.

The Long Range Plan is developed and published.

Elements of the adopted course of action are supervised by the executives who helped develop it for use in the Long Range Plan. ▯

INTRODUCTION TO OPERATIONS RESEARCH

Operations Research, or simply OR, has assumed a place of importance in modern-day business management. The authors through this paper will provide you with some insight into the OR approach.

By: Roger R. Crane, Principal in charge
and Joseph F. Buchan, Senior Consultant
Management Services Central Staff
Touche, Ross, Bailey & Smart

The subject of this discussion is Operations Research, or, in its commonly used abbreviation, simply OR. The logical beginning for such a discussion is to define Operations Research. The most accurate and comprehensive definition is that Operations Research is what OR people do. Since that may sound like begging the question, the following definition is volunteered, one which would probably be challenged by some OR practitioners. Operations Research is the process of conducting an explicit quantitative analysis of an existing operation, directed at developing improved methods of operating and making use of any scientific techniques which may sharpen the analysis or improve the operation.

Before proceeding to some of the more recent OR work on business problems, we wish to provide some insight into the OR approach by reference to some of the earlier work in the field. In particular, we want to get across the concept of "making a model of the operation" because this is fundamental to all OR work. A model is a simplified reproduction of the important relationships in an operation. The model may be a set of equations, a simple flow chart, or an elaborate computer program. If the model is an adequate representation of the operation, we can often learn how to improve the operation by experimenting with the model.
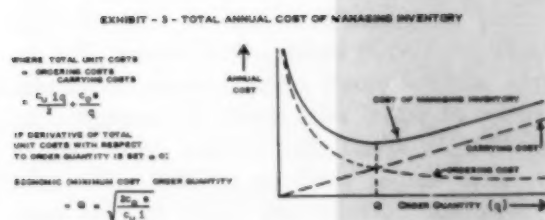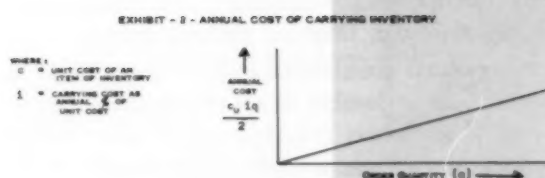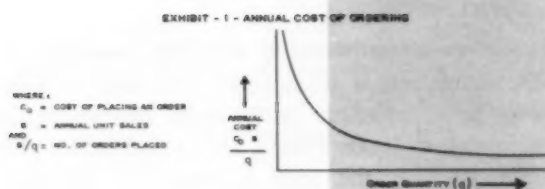
An Inventory Model

We might begin with Scientific Inventory Management because the basic inventory model is quite simple and has still proven widely useful. The model itself is somewhat of a classic, having first appeared in the literature about thirty years ago. Although many of you may be familiar with this model, we will spend some time on it to illustrate the typical assumptions and simplifications of a model. The basic model is illustrated in Exhibits 1 through 6.

Economic order quantities (how much to order)

Exhibits 1, 2 and 3 illustrate the cost model which is used to determine the most economic, or minimum cost, order quantity. The model assumes that the cost of managing inventory is made up solely of two costs:

(1) **ordering cost**: This is the additonal cost of placing an order — a cost which is considered to be independent of the size of the order. This might include set up costs in manufacturing, but only purchase order processing costs in retailing. As shown in Exhibit 1, the *annual* cost of ordering decreases at a decreasing rate as the order quantity increases. In other words a specific cost per order is spread over more units per order.

(2) **carrying cost**: This is the cost of inventory storage plus the opportunity cost of the money tied up in inventory. This is usually expressed as a percentage of the inventory cost per unit of time, such as 20% per year. As shown in Exhibit 2, the *annual* cost of carrying inventory increases in direct proportion to the quantity ordered. Note that this cost increases in proportion to one-half of the quantity ordered $(q/2)$. The model assumes that inventory decreases (through sales) at a constant rate from the order quantity to zero and is then replenished by another order quantity. Thus the average inventory is half way between zero and the order quantity, and carrying costs are based on this average.

EXHIBIT – 1 – ANNUAL COST OF ORDERING

WHERE:
c_0 = COST OF PLACING AN ORDER

D = ANNUAL UNIT SALES

AND

D/q = NO. OF ORDERS PLACED

$$\frac{c_0 \, D}{q}$$

ANNUAL COST

Order Quantity (q) →

EXHIBIT – 2 – ANNUAL COST OF CARRYING INVENTORY

WHERE:
c_u = UNIT COST OF AN ITEM OF INVENTORY

i = CARRYING COST AS ANNUAL % OF UNIT COST

$$\frac{c_u \, i q}{2}$$

ANNUAL COST

Order Quantity (q) →

EXHIBIT – 3 – TOTAL ANNUAL COST OF MANAGING INVENTORY

WHERE TOTAL UNIT COSTS
= ORDERING COSTS + CARRYING COSTS

$$= \frac{c_u \, i q}{2} + \frac{c_0 \, D}{q}$$

IF DERIVATIVE OF TOTAL UNIT COSTS WITH RESPECT TO ORDER QUANTITY IS SET = 0:

ECONOMIC (MINIMUM COST) ORDER QUANTITY

$$= Q = \sqrt{\frac{2 c_0 \, D}{c_u \, i}}$$

ANNUAL COST

COST OF MANAGING INVENTORY

CARRYING COST

ORDERING COST

Q   Order Quantity (q) →

As is shown in Exhibit 3, the total annual cost of managing inventory first decreases as the order quantity increases because of the rapid reduction in the unit ordering cost. At some point, this total annual cost begins to increase again as the reduction in ordering cost gets progressively smaller and is eventually outweighed by the increase in carrying cost. The mathematics of this particular model are such that the minimum total annual

cost occurs where annual carrying cost equals annual ordering cost.

Based on this cost model, the formula shown will permit determination of the most economic order quantity. Note that the total annual cost curve is rather flat near the minimum point. Thus the reorder quantity can be varied over some range near the minimum without significantly changing total costs. And because of the square root relationship, a 21% error in determining the carrying cost of the ordering will only introduce a 10% error in the determination of the economic order quantity.
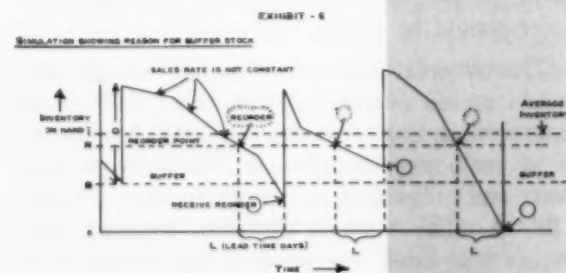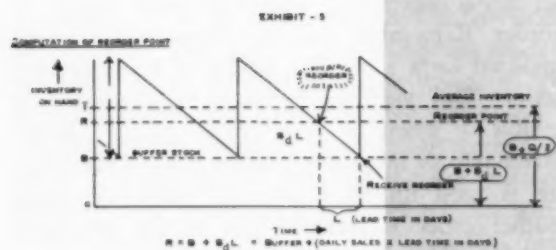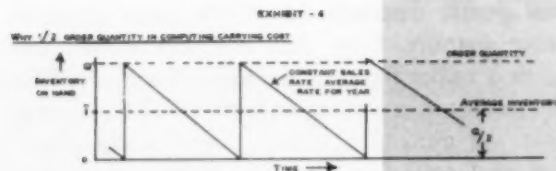
Reorder points (when to reorder)

"How much" to reorder has been determined, but this is inextricably bound up with "when" to reorder. Remember that the carrying costs were predicted on a particular model of inventory behavior. This idealized behavior is illustrated in Exhibit 4 where a new order quantity is received just as inventory reaches zero. This quantity is used up at a constant sales rate until another order is received just as the inventory reaches zero again.

This kind of idealized behavior does not happen in the business world, so the model behavior is made a bit more sophisticated, as indicated in Exhibit 5. First, the time lag between placing a reorder and receiving it is recognized. To compensate for this, the average expected sales during this lead time are calculated and that amount is added to zero in computing the reorder point — the level of inventory at which a reorder should be placed.

This is still inadequate because actual sales would exceed average sales in about half of the time periods. Everytime this happened there would be a temporary out-of-stock condition or back order and probably lost sales. Therefore, a buffer (B) or safety stock is added to expected sales during lead time. The result is the reorder point (R) which is used in this model.

The details of determining buffer stock will not be presented here. When lead times are fairly constant the distribution of sales about the average sales can be used to determine a buffer level with an associated probability of stock-out or back orders. If, for example, lead time were a constant one week and actual weekly sales only exceeded two and a half-times the average weekly sales in one week out of 20, setting the buffer at one and one-half times average weekly sales should insure that stock-outs would not occur more than 5% of the time.

EXHIBIT - 4

Why 1/2 ORDER QUANTITY IN COMPUTING CARRYING COST

EXHIBIT - 5

COMPUTATION OF REORDER POINT

$R = B + S_d L$ = Buffer + (Daily sales x Lead time in days)

EXHIBIT - 6

SIMULATION SHOWING REASON FOR BUFFER STOCK

If lead times also have a significant variation about the average, the determination of buffer levels and stock-out probabilities can be made by a Monte Carlo simulation. In this, tables are set up for the relative occurance of various lead times and various sales rates. A buffer level is chosen and the probability of stock-outs at that level is simulated by randomly selecting lead time and sales values from these tables and plotting the

effect on inventory level if the reorder point and quantity rules are followed. This is done repeatedly to determine the stock-outs which would occur over an extended time period for one buffer level. The process is then repeated for a number of buffer levels.

Simulation (experimenting with the model)

A simulation is illustrated in Exhibit 6. This shows how variations in the sales rate result in the inventory levels falling above and below the buffer level at the time a reorder is received. This illustrates very well how we can experiment with a model to learn more about the operation which it represents. Simulation is merely a means of rapidly producing the results which would be obtained if a given system were operated over some period of time. By following the reorder point and reorder quantity rules and using actual sales and lead time data, the expected stock-out and inventory level results of operating the proposed system for many months, or even years, can be quickly simulated and compared to the actual results from an existing system.
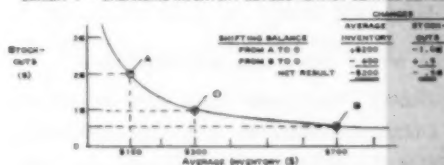
By repeated simulations such as that shown in Exhibit 6, it is possible to determine the expected values of stock-outs (or back orders) for various corresponding expected average inventory levels. Exhibit 7 summarizes the typical results of one such series of simulations for just one level of average sales and one distribution of sales about the average. Stock-outs are reduced as average inventory is increased, but not in direct proportion.

Reducing stock-outs from 2% to 1% requires only a $200 increase in average inventory, while reducing stock-outs from 1% to 1/2% requires an additional $500 increase in inventory. This relation will commonly occur because of the distribution of actual sales about the average sales. For example, actual sales of four times average may occur in one week out of 100, while sales of twice the average may occur in one week out of ten.

The Common Inventory Management Problem

In any large inventory, several items may have similar sales — both as to average and as to distribution. The points A and B in Exhibit 7 show the existing stock-out and average inventory levels for two such similar items at one company. Obviously these two items were not being controlled to the same extent. Yet there was no good reason for the difference except the large number of items which had to be controlled and the lack of a formal system for controlling them.

EXHIBIT-7 — BALANCING INVENTORY LEVELS AGAINST SERVICE LEVELS

EXHIBIT-8 — RELATION OF INVENTORY TIME SUPPLY TO SALES
OLD SYSTEM

EXHIBIT-9 — RELATION OF INVENTORY TIME SUPPLY TO SALES
SCIENTIFIC INVENTORY MANAGEMENT

By letting management select 1% stock-outs as a satisfactory level and by applying the re-order point and reorder quantity rules, the balance of inventory to service levels was shifted to point O for both items. As is shown in the exhibit, the overall stock-outs for A plus B and the overall average inventories for A plus B were both reduced.

Undesirable disparities in treatment of different inventory items, similar to that shown in Exhibit 7, are quite common in businesses which process a large volume of inventory transactions, but lack a formal inventory management system. That is why the installation of such a system is often accompanied by simultaneous reductions in stock-outs and inventories, however paradoxical this may seem at first glance.

The x's in Exhibit 8 represent the actual relation between annual sales and average inventory on hand (expressed as a percentage of annual sales) for a number of items at one company under their old inventory procedure. Notice the haphazard scattering of these points.

The proper inventory to sales balance

The slanted solid line shows where these points should have fallen if reorder rules had been scientifically set and exactly applied. Every item on this line would have the same level of protection against stock-outs and would be ordered so as to minimize total inventory costs.

Note the points X, Y and Z, representing three inventory items which have the same unit costs, ordering costs and carrying costs but different annual sales. And note how the required time supply of average inventory decreases as sales increase. The required inventory per cent to sales is 26.5% for item X, but only 8.4% for item Y and 2.6% for item Z. This happens because the order quantity (and consequently the average inventory) only increases in proportion to the square root of sales. In this case, buffer stock is based on a Poisson distribution of sales and also increases in proportion to the square root of sales.

For X, Y, and Z (with the same unit costs) the logarithmic relation of inventory time supply to sales will be linear whether sales are expressed in units or dollars. For items with differing unit costs to fall on the same straight line, however, sales must be expressed in dollars. Note point M for an item with the same 100 unit annual sales as item X, but with a unit cost of $2.00 rather than $1.00. It falls on the same line as X at 20% of $200 but would not at 20% of 100 units.

For the interested technician, the following de-
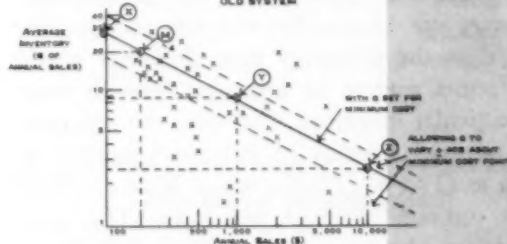
15
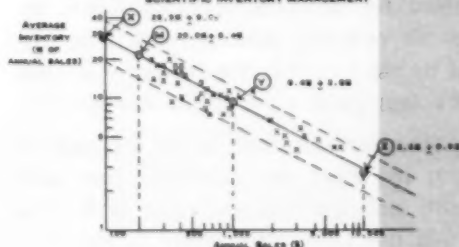
tails are provided for those who wish to check the calculation of point X. Those who are not interested should skip to the next paragraph.

Ordering cost (C_o)   = $2.00
Unit cost   (C_u)   = $1.00
Inventory carrying % (i) =   .2 (or 20%)

Sales (S) were for a 50 week year while lead time (L) was a constant two weeks. Therefore average sales during lead time$=S/25$

Sales distribution was Poisson (proportional to the square root of average sales). Therefore the probability of a stockout was limited to 2 or 3% by setting;

Buffer stock (B) $= 2\sqrt{S/25}$
Economic order quantity (Q) $= \sqrt{2C_o S/C_u i}$
Average inventory (I) $= Q/2 + 2\sqrt{S/25}$
For item X, with S = 100 (and SC_u = 100)
$Q = \sqrt{(2)(2.00)(100)/(1.00)(.2)} =$
$\sqrt{2,000} = 44.7 = 45$
$I = 45/2 + 2\sqrt{100/25} = 26.5$
$IC_u = 26.5 (\$1.00) = \$26.50$ or 26.5% of
$SC_u = \$100$

The slanted broken lines which are shown on Exhibit 8 enclose the area in which the points relating inventory to stock-outs would fall if the order quantities were permitted to vary plus and minus 40% about the most economic order quantity.

The 40% figure is somewhat arbitrary, but in many cases the total unit inventory cost (Exhibit 3) curve is so flat near the minimum cost point that variations of plus or minus 40% in the order quantity will only increase total unit costs about 10%. (With increasing inventory carrying cost percentages, this rule-of-thumb becomes less and less satisfactory). A moment's reflection about the nature of inventory costs suggests that they are seldom known accurately to within 10%. Therefore a range of order quantities is probably satisfactory with a consequent range of permissable inventory time supply on hand.

Exhibit 9 shows the annual sales to average inventory relations for the same items as shown in Exhibit 8 after scientific inventory management had been installed on these items. The disparities in treatment of items had been greatly reduced and the remaining disparities are not very significant costwise.

The difficulty of determining inventory cost

Before leaving the subject of inventory, we might elaborate briefly on the important subject of costs. Most OR applications to business problems are vitally affected by the accuracy of cost estimates. The word "estimates" is used intentionally. Despite the painstaking efforts of the accounting department, most business cost fig-

ures are still estimates or approximations based on various assumptions and allocations.

In many instances, the averaging and allocating on which the cost accounting figures are based, make the figures too crude for OR use. How many businesses, for example, provide accurate accounting figures on ordering costs or carrying costs?

Improvement when costs are unobtainable

It is interesting to note that the inventory model can often be used to improve inventory management, even when useful inventory costs are unobtainable. Consider an inventory situation like that illustrated in Exhibit 8 where the inventory control varies greatly from one item to the next. This is not unusual. Nor would it be unusual to find that there was no reliable information on ordering and carrying costs and therefore no way of establishing the most economic order quantities.

The company is incurring inventory cost, however, even though the amount is unknown. In general, the ordering cost and the carrying cost percentage are both a function of the company rather than the inventory item. In other words, these factors tend to be a constant for all items in a particular inventory. Therefore the economic order quantity formula of Exhibit 3 can be rewritten as $Q = K\sqrt{S/Cu}$ where $K = \sqrt{2Co/i}$ and is constant although unknown. The order quantity can also be defined as $Q = S/N$ where N is the number of orders placed. Equating these two definitions of Q enables the number of orders placed to be expressed as $N = \sqrt{SCu/K}$. This relationship applies to each inventory item and to the sum of all inventory items.

By summing historical data on total number of orders placed and total costs of sales (SCu) for all items in the inventory and inserting these sums in the above equation for N, a value can be determined for K. This value combines implied costs for ordering and carrying inventory — implied by the fact that the company is operating on the average at a particular reorder level.

Reorder quantities can then be set for each inventory item by using the individual item sales and unit costs and this common value of K. This approach will not necessarily result in the most economic ordering policy, but it will result in a consistent policy for all inventory items. It will insure that there is no increase in the total number of orders placed except as sales increase. And it will nearly always result in a decrease in average inventories.

Varying the Basic Model

There are many useful variations on the basic inventory model which was just discussed. The above model assumes that perpetual inventory records are continually reviewed so that knowledge of reaching the reorder point is instantaneous. Where inventories are periodically reviewed, a provision can be made for sales during the review period (time between counts).

In another situation, where periodic inventory reviews are made and ordering costs are unimportant, a replenishment level system may be appropriate. Such a system might be used, for example, where reorders merely transfer company owned inventory from a central warehouse to decentralized selling locations. In the replenishment system, the order quantity is not constant, but is equal to the difference between a fixed replenishment level and the actual inventory level at the time of the review.

These variations need not concern us. The main purpose of the discussion up to this point is to explain the twin OR concepts of "model building" and "simulation" by specific reference to a model which is both simple and useful — the basic inventory model.

Some Businesses With Scientific Inventory Management

To illustrate the wide usefulness of this model and its variations, consider the variety in the following partial list of businesses in which we have successfully applied scientific inventory management:

- Automotive manufacture (service parts)
- Chemical coating (production materials)
- Department Stores (stores and warehouse inventories)
  Children's Furniture
  Cooking Utensils
  Cosmetics & Drugs
  Curtains
  Earthenware
  Notions
  Paints & Wallpaper
  Stationery
  Towels
- Grocery supermarkets (warehouse inventories)
- Papermill (spare parts and stores)
- Wholesalers (drugs, books and stationery)

Linear Programming

The foregoing discussion centered on an OR model of a particular problem which is common to very many businesses. The following discussion will center on an OR model which is applicable to a variety of business problems. This model or technique is very useful for solving problems with many inter-related alternatives as long as they can be fitted into a particular mathematical framework. The versatility of this technique springs from the fact that many problems which seem quite dissimilar from a business viewpoint do fit a common mathematical framework. The technique is linear programming.

In order to illustrate the technique, let us consider its application to a common marketing problem — the scheduling of which plants shall ship to which warehouses. This problem illustrates a classic and simple version of linear programming — the so called "transportation model". The word "transportation" refers to the mathematics of the solution, not the physical aspects of the problem. A number of business transportation problems cannot be solved by this method. On the other hand it is useful for many problems which have nothing to do with transportation.

All linear programming problems are essentially allocation problems, problems of allocating certain resources to particular tasks. The simplest sub-class of linear programming problems is the "assignment problem," such as the assigning of men to jobs, where any one resource or man can completely satisfy the requirements of any one task.

"Transportation problems" are somewhat more sophisticated and apply to a broader class of problems, including the one discussed here. The distinguishing feature of "transportation" problems is that the requirements for each task and the capacity of each resource can be expressed in a common unit of measure. In our example, a ton of plant 1 output is identical with a ton of requirements at any warehouse and with a ton of output from either of the other two plants. Therefore, we have a "transportation" type problem.

This is still a sub-class of linear programming problems and an even more sophisticated, more general technique, known as the "Simplex method" can be used on problems for which the "transportation method" is inapplicable. The "transportation model," however, offers a good balance between complexity and utility for the purpose of introducing the layman to linear programming.

A Transportation Model

The particular problem described here is so small that linear programming would not be used on it in practice. This small problem, however, will highlight the typical interaction among a series of related choices which makes linear programming so useful for larger, life size problems.

Exhibit 10 illustrates a simple problem of allocating the output of three plants to four warehouses in such a manner as to minimize the total freight or transportation cost. (It was the early use on just this kind of business problem which resulted in the label of "transportation model" for this particular type of linear programming). Four warehouses are to be supplied from three plants. The output of each plant in tons is shown inside the square and the needs of each warehouse are shown outside the circle. The cost per ton to ship from each plant to each warehouse is shown alongside the dotted line connecting them. Costs of shipping from plant 1 to warehouse C and D and from plant III to warehouses A and B are prohibitively high and these routes are excluded from consideration.

Linear equations

The problem which is presented schematically in Exhibit 10 can be completely described by a set of linear equations such as the following where T represents tonnage, C represents cost per ton and the subscripts indicate the particular combination of plant and warehouse:

Plant I capacity restrictions =
$$T_{IA} + T_{IB} + T_{IC} + T_{ID} + T_{IH} = 170$$

and so on for plants II and III
Warehouse 'A' requirements =
$$T_{IA} + T_{IIA} + T_{IIIA} = 140$$

Total cost =
$$T_{IA}C_{IA} + T_{IB}C_{IB} + - - T_{IIID}C_{IIID}$$

Since total plant capacity exceeds total warehouse needs, a hypothetical warehouse H is included in the problem formulation. Any tonnage shown for warehouse H in the solution will merely represent unused capacity for the corresponding plant. The equation for warehouse H needs is:

$$T_{IH} + T_{IIH} + T_{IIIH} = 95$$

This also explains the T_{IH} term in the plant

I restrictions which enables that equation to be written as "equal to 170" instead of "less than 170". The hypothetical warehouse tonnages can be ignored in the total cost equation because the unit cost for such shipments are all zero.

The resulting nine equations completely describe the problem. The size of the problem (3 plants

EXHIBIT-10 — MINIMIZE FREIGHT COST OF SUPPLYING FOUR WAREHOUSES FROM THREE PLANTS

EXHIBIT-11 — ONE FEASIBLE SOLUTION AND ITS TOTAL COST

EXHIBIT-12 — EVALUATING SOLUTION AND REVISING IT

and 5 warehouses) also tells us that seven combinations of plants and warehouses will be used in the solution although this will include some shipments to the hypothetical warehouse.

A common unit of measure

Note that the above equations are all linear; in other words there are no exponents on any of the terms in any of the equations. The cost per ton over any route is the same regardless of the amount shipped. This linearity means that the set of equations are amenable to solution by linear programming techniques. It is a fact that a common unit of measure applies to all plant — warehouse combinations, however, that renders it amenable to the "transportation" technique; the fact that a ton of plant I output = a ton of plant II output = a ton of warehouse A needs and so on. If this were not true, the problem might still be solved by the more sophisticated "Simplex method" of linear programming.

Without this ability to exactly transfer any one unit between any two plant-warehouse combinations, the problem could not be solved by the simpler "transportation method" unless it could be somehow adjusted into an equivalent problem which did have one common unit of measure. This may require considerable ingenuity, but is often possible. If different products were to be shipped with different costs per ton, for example, the size of the problem could be increased to specify product by warehouse needs and product by plant outputs.

In one case of allocating products to particular machines, a unit of any one product required different production times on different machines. Therefore, an hour's production on one machine did not equal an hour's production on another machine. It was noticed, however, that the ratio of operation times between any two machines was constant for all jobs. Therefore an equivalent problem was formed by determining equivalent product requirements and adjusted machine capacities so that the equivalent production from one adjusted hour was the same for all product-machine combinations. After solving this problem, the answer was converted back into real units of product and machine hours.

Obtaining an initial solution

The common method of solving a transportation problem is to set up a cost table (or matrix) such as shown in Exhibit II where each value in the table is the unit cost from one plant to one warehouse. An allocation table (or matrix) is set up showing the total needs for each warehouse and total supply from each plant. A first feasible solution is then determined.

The solution in Exhibit II started by using the lowest cost combination of plant I and warehouse A. The tons allocated are limited by either needs or supply — in this case by warehouse A needs of 140 tons. After selecting the first plant to warehouse allocation, subsequent selections are restricted by the following rule: The supply from one plant must be exhausted before allocating product from the next plant, and the needs of one warehouse must be filled before allocating product to another warehouse. With this rule, the rest of the allocation table in Exhibit II was filled in.

This solution is a feasible one, but it is only one of many feasible solutions. It is therefore evaluated to see if it is the best possible solution (minimum cost). The evaluation procedure will not be detailed here, but it results in the shadow price table shown in Exhibit 12. This shows cost figures for each possible but unused allocation of plant output to warehouse. These costs can be interpreted as the cost of not using a particular allocation combination. If one of these costs of an unused combination exceeds the corresponding cost of using that combination, as shown in Exhibit II, the solution is not the best.

Obtaining the best solution

The cost of not using plant II to supply warehouse A is $1.50 per ton compared to the $1.30 per ton cost of using that combination. Thus $ .20 can be saved for every ton allocated to the plant I — warehouse A combination. Such an allocation must also be accompanied by an equal reduction in the allocations to both I-A and II-B and an equal increase in the allocation to I-B. This limits the plant II — warehouse A allocation to 90 tons and results in the revised solution shown in Exhibit II.

An evaluation of this solution would show that it is in fact a best solution. (Several different solutions may yield the same minimum cost). Most real problems will require a number of successive solutions and evaluations before the best one is reached.

This problem could have been easily solved without linear programming. A person can quickly see that the choice of the $1.00 cost combination must also be accompanied by a choice of the $2.20 combination, whereas, choice of the $1.30 cost is accompanied by choice of the $1.70 cost. In a problem of 10 plants and 20 warehouses, however, all of these interactions are not obvious and only a systematic procedure is likely to result in a best solution.

The importance of isolating variable costs

Before leaving the subject of linear programming applications in business, we might once again stress the importance of sound costs in achieving successful OR applications. A linear programming model is directed at either minimizing a linear cost function or maximizing a linear profit function. The model assumes that the costs are purely straight line variable cost — that the costs or profits increase the same amount for every added unit. Therefore the costs used in the model should be free of any allocations of fixed cost.

The purely variable costs associated with various combination of choices in the purchasing, manufacturing and distribution areas are seldom readily available from the existing account and budget structure. Therefore, the framing of business problems in a manner which is amenable to linear programming solution usually requires considerable cost analysis work.

In one case of allocating products to machines, for example, the linear programming solution maximized the sum of the profit contributions from each product on each machine. Profit contribution was the selling price of the product minus the variable cost of producing it on any particular machine. The variable cost of each product varied among different machines and these costs could only be determined by painstaking analysis and elimination of allocated depreciation, taxes, maintenance, etc. The linear programming problem could be solved on a computer in 15 minutes or by hand in a few hours. The determination of all relevant costs required a number of man months.

Some Business Uses of Linear Programming

Whereas the inventory model was presented because inventory management is a common problem in business, the linear programming model was presented because it may be applicable to a variety of business problems. The following is a partial list of business problems to which we have applied linear programming, although not necessarily the transportation model:

- Determining where to build a new plant. Some 30 potential plant sites were evaluated with respect to minimizing the sum of total inbound and outbound transportation costs to 150 sales districts and from a half dozen sources of supply.
- Scheduling production jobs on paper machines. Some 100 odd products were scheduled on nine paper making machines so as to maximize profit contribution.

- Minimizing waste (decal) in cutting paper rolls into desired widths. Rolls 92" wide were cut into a number of widths from 7" to 72". Varying lengths of each width were needed. The minimum waste solution used six different combinations of knife settings.
- Determining the best mix of plywood sheets to produce. From various available quantities of about fifteen different plywood veneers (different as to grade and thickness) some 40 different end products were scheduled so as to maximize profit contribution.
- Determining the best mix of logs to purchase. From the desired mix of plywood end products, and hence of veneers, the purchase quantities of four different classes of logs (which yield different distributions of veneers) was set so as to minimize cost.
- Allocating truck tractors to trailers. Tractors were assigned to hauling trailers from widely scattered locations in such a manner as to minimize costs.
- Three problems were solved for a grain processor; determining (1) best purchase mix of grain, (2) best blending mix of grain into finished product and (3) best allocation of production between plants.

Some Other Applications

The preceeding discussion should provide some insight into the typical Operations Research approach to business problems: the construction and manipulation of a model which reproduces the important quantitative interactions within the problem. The model may be one of a particular business problem, such as the inventory model, or it may be a general technique, such as linear programming, which is applicable to a variety of business problems. An inventory model and a linear programming technique have been discussed in some detail. And some inventory installations and linear programming applications have been enumerated. We will close this introduction to OR by enumerating just a few other examples of business problems to which the OR approach has been successfully applied.

- A fleet of trucks carried products from a central warehouse to satisfy demands at a number of decentralized stores. Most of the store demands were for less than truck loads. Trucks were scheduled so as to minimize the total number of truck miles.

- A market survey showed the common results of a small percentage of the customers contributing a large percentage of the sales. Experimentation determined the expected results of varying amounts of sales efforts for obtaining new customers and for holding old customers. The best allocation of selling effort among customers was determined for a fixed sales budget. The expected return from various sizes of sales force was also determined.

- Extruded metal stock of various lengths is made by pouring ingots, sawing the ingots into billets, forming long extrusions from the billets, cutting long extrusions into stock lengths and cutting the stock lengths into desired final lengths. The required number of final lengths was converted into scheduled billet and ingot lengths so as to minimize the cut-off scrap in the overall operation.

- The production of items with seasonal and random variations in demand was scheduled monthly so as to minimize the total costs of hiring, layoffs, overtime, setup, back order and inventory carrying.

The result was a considerable improvement which could be achieved even with considerable errors in sales forecasting or in estimation of various costs.

- Analysis showed that the cost of bottled products, including washing of returned bottles, could be significantly reduced by changing to a less elegant brand identification on the bottle. Certain sales territories were considered non-critical by management and it was possible to experiment in these territories with the effect on sales of cheaper brand identification.

- A mathematical model was set up to simulate the operation of a finance company branch office. The model permitted the manipulation of some 23 variables, including the volume, interest rate, average maturity length and expected loss rate on customer notes as well as the interest rate and finance requirements for company borrowings. An IBM-709 produced quarterly earnings statements, balance sheets and critical ratios for 5 years simulated operation in 12 minutes running time. The model was useful for both budget planning and budgetary control. ◼

NEW MEMBERS

WELCOME

NEWS *About Members* . . . .

MARSHALL ROBINSON of the Los Angeles Chapter led an American Management Association workshop seminar on "Preparation of the Operating Budget" at San Francisco on April 26-28. Another Los Angeles Chapter member ROBERT WHITMORE on May 17 participated in a panel presentation on "Budgetary Control" at the Insurance Accounting & Statistical Association's International Conference in Los Angeles.

The Louisville Chapter held a joint meeting with the local chapter of The National Association of Accountants on April 18. The guest speaker was our own former national president VISSCH MILLAR.

The Chicago Chapter climaxed its 1960-61 technical sessions with DR. W. D. KNIGHT of the University of Wisconsin leading a discussion of "Managerial Budgeting". DR. KNIGHT has been a prime force in the development of the NSBB textbook which will be published shortly. KEN BENNETT, president of the Milwaukee Chapter, recently conducted a seminar on "Profit Management" at the Management Institute of the University of Wisconsin. And ROSCOE HANKIN of that chapter enlightened the Milwaukee Chapter of Women Accountants on general budget background at their meeting on May 22. Milwaukee Chapter members are scheduled to furnish a panel for a Chicago Chapter meeting and a speaker for a Minneapolis Chapter meeting in the near future. They will also provide a panel for a Racine-Kenosha NAA Chapter meeting next year.

Cincinnati Chapter members EUGENE MIDDLEKAMP, BRUCE MAYHALL, RICHARD SHAW and LARRY HAVERKAMP recently appeared before the Ford Motor Company's OKI (Ohio, Kentucky and Indiana) Accountant's Club to discuss various phases of budgeting. Their presentation was most favorably received.

REGIONAL CONFERENCES

MIDWEST CONFERENCE — The Third Annual Midwest Conference is scheduled for October 19-20 at the Pick-Fort Shelby Hotel in Detroit, Michigan. Program plans include the following subjects:

(1) Cooperation With Universities

(2) Direct Costing — Key to Effective Profit Planning and Budgeting Control

(3) Control Budgets — Short Range

(4) Forecasting, Using Machine Method

(5) Return on Investment

(6) Adjusting Budgets — Flexible

This conference is proving to be extremely popular with all NSBB members in the midwestern chapters. First held in Chicago, then in Milwaukee and now in Detroit, it has in only a few short years established itself as an institution.

NORTHEASTERN REGIONAL CONFERENCE — This conference will be held Saturday, October 28, at the Roosevelt Hotel in New York City. The announced theme is "Plans, People and Profits".

EXCERPT FROM CHAPTER LETTER

Occasionally a chapter newsletter will contain information about a program which is worthy of wider distribution. Such is the case of the April issue of the Los Angeles Chapter edited by BRUCE ROGERS, Chapter Secretary.

Dr. Frank R. Moothart, Assistant Controller—Accounting, Hughes Aircraft Company, Culver City, Calif., was the speaker of the evening and presented a very informative talk on "Research and Development Budgeting".

Dr. Moothart described the following as some of the factors that complicate research and development budgeting:

1. *One principal customer* — the U. S. Government. National political and economical considerations often cause extreme fluctuations in a company's contractual status.

2. *Force-in-being concept of mobilization.* Under current military concepts, this country must maintain the capacity to deter war and to repel and decisively counter any possible attack. This requires continuous technological advancement through research and development projects. A project started today and budgeted for the year may be obsolete tomorrow.

3. *Defense procurement practices.* Certain practices make it difficult for R and D organizations to forecast sales and establish financial plans. For example, procurement officials are sometimes required to give preference to small business firms, to firms in labor surplus areas, or to firms in dispersed areas. Then, contracts may be issued to various firms to increase competition; to establish alternate sources; or to make use of Government-provided facilities held by a contractor.

4. *Restrictions.* A company's flexibility may be handicapped through Government control of a contractor's make-or-buy program and intracompany transactions.

5. *New developments.* Development periods for new, complex projects are very long and require projection of advancements in the state of the arts. There is great possibility of termination of a program before completion, or of cost overruns or delay due to technical problems.

6. *Adjustments.* Final sales and profit on a contract may not be known for years after the work has been started. Contract finalization may involve retroactive adjustments affecting several prior annual plans.

DR. MOOTHART then discussed some techniques applicable to research and development budgeting:

1. Establish and maintain a reasonable level of manpower to be utilized for contracts. Let company sponsored projects take up the slack.

2. Establish and maintain a reasonable level of diversified, plant capacity. Acquire flexibility through a subcontracting program, a make-or-buy program, and intracompany assist work.

3. Make use of leased facilities or Government-furnished items.

4. Determine areas of opportunity; establish capability to go into areas of high potential.

5. Establish responsibility units; delegate and pin-point responsibilities; and, set profit objectives for each unit based on:

   Long range sales plan, annual financial plan, moving forecast and flexible budget techniques.

6. Establish responsibility accounting and measure the performance of each responsibility unit against the approved plan.

7. Implement accounting and reporting that is compatible with the organization and the budgeting and that covers controllable items. Otherwise, alibis and deviations are built into the plan, rendering it less effective as a management control device.

COMING IN THE NEXT ISSUE . . . Dallas Conference highlights . . . Election results . . . New national president's message

SAN FRANCISCO

On April 13, Regional Director H. R. Hawley presented the charter to the new San Francisco Chapter. The San Francisco Chapter is a spin-off of the former San Francisco Bay Area Chapter which has changed its name to the San Francisco-Peninsula Chapter. The officers of the new chapter are as follows:

President	Fred Tegeler, Jr.
Vice President	Kyle M. Barriger
Treasurer	H. Richard Hawley
Secretary	Wilho Ahola

Charter members are:

R. F. Abele	H. E. Firth	A. D. Moor
W. E. Ahola	J. T. Fisher	M. S. Moyal
K. M. Barriger	J. C. Hardin	J. P. Nathan
R. K. Black	W. B. Harford	C. F. Peirano
A. Bryant	H. R. Hawley	J. C. Schraa
J. Carleton	M. Headrick	T. K. Strong
R. F. Coleman	R. W. Johnson	F. A. Tegeler
A. E. Ellison	A. H. Kessler	L. O. Viales
W. P. Feiten	E. J. Lage	J. T. Wheeler
		A. H. Winkler

Welcome

H. R. Hawley presents the charter to Fred A. Tegeler, Jr., President. At the far left is Emil J. Lage and at the far right is Albert E. Ellison.

NEW CHAPTERS

Don Bacon presents the charter to M. R. Tyran, President.

CEDAR RAPIDS

The Charter for the Cedar Rapids, Iowa, Chapter of NSBB was presented in March by Vice President Don Bacon. The officers of the new chapter are as follows:

President	M. R. Tyran
Vice President	James Carrithers
Secretary	John Kovanda
Treasurer	Walter Badger

Charter members are:

Walter Badger—McGladrey, Hansen, Dunn & Co.
Hal Beile—Collins Radio Co.
Joe Binder—Collins Radio Co.
Ed Bock—Peat, Marwick, Mitchell & Co.

James Carrithers—Coe College
James Field—Collins Radio Co.
John Hancy—Square D Company
John Jochem—Allis-Chalmers Mfg. Co. — from
   Member-at-Large
Robert Kasten—Cherry-Burrell Corp.
John Kovanda—Cherry-Burrell Corp.
Larry Nelson—Allis-Chalmers Mfg. Co.
Roger Nordyke—Amana Refrigeration, Inc.
Ray Nystuen—Allis-Chalmers Mfg. Co.
Mike Tyran—Collins Radio Co.
John Whalen—Collins Radio Co.
E. A. Williams—Collins Radio Co.
Robert Young—Altorfer Machinery Co.

BUSINESS BUDGETING MAGAZINE

The only national publication of the National Society for Business Budgeting is the "Business Budgeting" magazine. It is issued every other month. The September issue will contain, in article form, the various talks, lectures and discussions presented at the National Conference held in May, as well as items of pictorial interest to the membership. The other issues will carry timely articles on the general subject of budgeting in all of its phases in modern business. Each issue will, as usual, contain sections devoted to news, both National and local, permitting every chapter member to be kept informed of activities of the Society at the National level and within each chapter.

Contributions by NSBB members serve as the principal source of material for "Business Budgeting" magazine. Members are encouraged to turn in articles of their own or from other sources, properly authorized. Although chapters are assigned responsibility for furnishing articles for specific issues, it is not intended to discourage any member, and particularly a Member-at-Large, from submitting his contribution at any time. Submission of articles by non-members is also welcomed, with the assurance that their contributions will receive equal consideration.

Articles should be submitted in "complete form," ready for publication. This means:

1. Typed, preferably double-spaced, on one side of page only;

2. Articles checked for completeness, correctness, and pages numbered;

3. Name of author, business affiliation, and background data about author;

4. Charts, exhibits, illustrations, etc., properly numbered or identified.

A total of about 15 pages is encouraged, although this should not necessarily be regarded as a "must." Short items of one or two pages on subjects of interest to our members are also appreciated. Naturally the quality of the article is more important than the length.

The news section of "Business Budgeting" depends entirely upon local chapters for chapter and individual news. Each issue of every chapter newsletter should be mailed to the Editor, along with additional material such as interesting photographs, news clippings, "letters to the editor," and what have you. This can be a most interesting section of the magazine, but depends upon the individual chapters to keep it so. ▣

Meet me in St. Louis Looie, meet me at the Conference!

THE 1962 NATIONAL CONFERENCE

ST. LOUIS, MISSOURI   MAY 17-18